	Document #	Date Effective
GLAST LAT PROCEDURE	**LAT-PS-01225-02**	24 Feb 2003
	Prepared by(s) Paul Dizon	Supersedes None
	Subsystem/Office Calorimeter Subsystem	

Document Title

CAL Pre-Electronics Module (PEM) Assembly Procedure

DRAFT

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT) Calorimeter

Pre-Electronics Module (PEM) Assembly Procedure

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
01	8 January 2003	Initial Draft
02	24 February 2003	Process revisions

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1 INTRODUCTION

1.1 PURPOSE

This document describes the procedure required for the assembly of the Calorimeter (CAL) Pre-Electronics Module (PEM). The assembly procedure is divided into two sets of operations:

- Insertion of CsI (Cesium Iodide) Crystal Detector Elements (CDEs) into the composite structure
- Installation of the Close-Out Plates onto the PEM Mechanical Structure to form the completed PEM

1.2 SCOPE

This document contains details concerning the assembly procedures for integrating the components of the Pre-Electronics Module. Procedures for assembling and certifying the CDE Insertion tooling and inspecting and handling CDEs and elastomeric cords are contained in other documents and referenced herein.

1.3 APPLICABLE DOCUMENTS

Documents and drawings that are applicable to this procedure are listed below.

1.3.1 Documents

GSFC-433-MAR-0004	GLAST Mission Assurance Requirements for the Large Area Telescope Phase C/D/E
NASA-STD-8739.7	Electrostatic Discharge Control
LAT-SS-00115	LAT Mechanical Systems – Level III Specification
LAT-DS-01133	CsI Crystal Detector Element Specification
LAT-DS-00239	CsI Crystal Detector Element Specification for the Engineering Model
LAT-DS-00809	CAL CsI Crystal and CDE Handling Procedure
LAT-SS-00601	CAL Structure to CDE Interface Control Document
LAT-SS-00241	PEM Mechanical Structure Specification
LAT-PS-01231	PEM Mechanical Structure Assembly Procedure
LAT-DS-00984	Specification for Silicone Elastomeric Cords
LAT-MD-00039	LAT Performance Assurance Implementation Plan
LAT-MD-00228	GLAST LAT CAL, TKR, & DAQ Contamination Control Plan

1.3.2 Drawings

LAT-DS-01224	Pre-Electronics Module Assembly Drawing
LAT-SS-00241	PEM Mechanical Structure Specification
LAT-DS-01230	PEM Mechanical Structure Assembly Drawing
LAT-DS-00917	Top Frame
LAT-DS-00918	Composite Structure
LAT-DS-00919	Base Plate
LAT-DS-00920	Close-Out Plate X
LAT-DS-00920	Close-Out Plate Y
LAT-DS-00922	Nut
LAT-DS-00920	Bumper Frame
LAT-DS-00927	Titanium Insert, Side

B8679	Guide Post, Electronics Card
B8680	Support, X, Electronics Card
B8681	Support, Y, Electronics Card
LAT-DS-00TBD	CDE Insertion Tooling Assembly
TBD	Insertion Tooling Base Plate
TBD	Carriage Rails
TBD	(+) Carriage
TBD	(-) Carriage
TBD	Cord Insertion Mandrel
TBD	Wire Guide Block

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Acronyms

AFEE	Analog Front End Electronics of the Calorimeter
CAL	Calorimeter Subsystem of the LAT
CDE	Crystal Detector Element of the PEM
CsI	Cesium Iodide
DPD	Dual Pin Diode
GLAST	Gamma-Ray Large Area Space Telescope
LAT	Large Area Telescope
PDA	Pin Diode Assembly
PEM	Pre Electronic Module of the CAL
TBD	To Be Defined
TKR	Tracker
TBR	To Be Resolved

1.4.2 Definitions

Analysis	A quantitative evaluation of a complete system and/or subsystems by review/analysis of collected data
Demonstration	To prove or show, usually without measurements of instrumentation, that the project/product complies with requirements by observation of the results.
Inspection	To examine visually or use simple physical measurement techniques to verify conformance to specified requirements.
kg	Kilogram
mm	Millimeter
Testing	A measurement to prove or show, usually with precision measurement or instrumentation, that the project/product complies with requirements.
Validation	Process used to assure the requirement set is complete and consistent, and that each requirement is achievable.
Verification	Process used to ensure that the selected solutions meet specified requirements and properly integrate with interfacing products

2 PRE-ELECTRONICS MODULE

The Pre-Electronics Module (PEM) consists of the Composite structure, 96 Crystal Detector Elements (CDEs), and inner Close Out plates. The PEM interfaces with the Analog Front End Electronics (AFEE) and the Side Panels. Figure 2-1 below shows the PEM before attachment of the final close out plate.

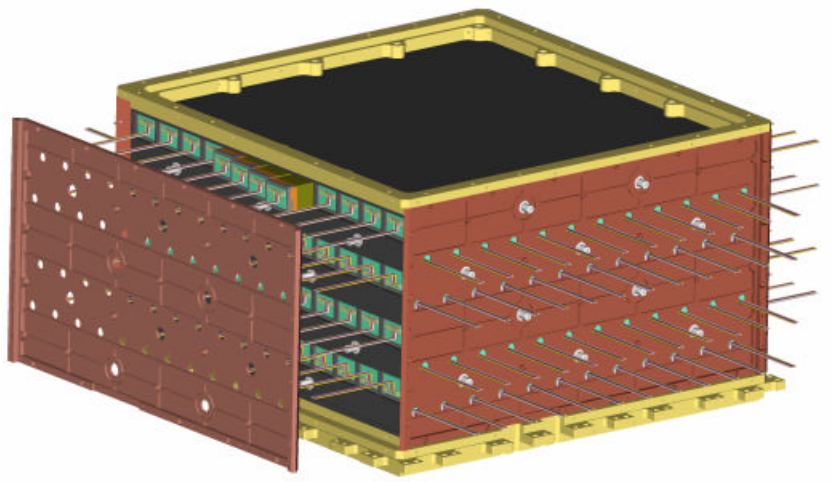


Figure 2-1 – Calorimeter Pre-Electronics Module

2.1 PEM Mechanical Structure

The PEM Mechanical structure is an array of cells arranged in a hodoscopic array containing 8 separate layers. Each layer contains a row of 12 cells into which CDEs are inserted. CDEs are inserted into cells along with elastomeric cords positioned along all four corners of the CDE so that the CDE is supported in the cell only at the corners.

2.1.1 CDE Numbering

The eight layers of the Mechanical structure are numbered in increasing order, with Layer 0 nearest to the top of the PEM, and Layer 7 nearest to the baseplate. CDEs are oriented in the same direction within each layer. Layers alternate between the '+' ends of CDEs pointing towards the +X side of the structure for the even-numbered layers, and the '+' ends towards the +Y side of the structure for the odd-numbered layers.

Each row of CDEs will be identified by the axis, X or Y, to which it is aligned, and the position of the row relative to the top of the PEM. Thus, the row of CDEs nearest to the top of the PEM is Row X0, immediately underneath is Row Y0, and continuing downward with Row X1 next, and finishing with Row Y3 nearest to the PEM baseplate.

CDE numbering per row is referenced with the zero-numbered CDE to the left when looking at the +X or +Y side. CDE numbering increments to the right, again when looking at the +X or +Y side. Figure 2-2 depicts the arrangement of the rows of CDEs in the Mechnical structure.

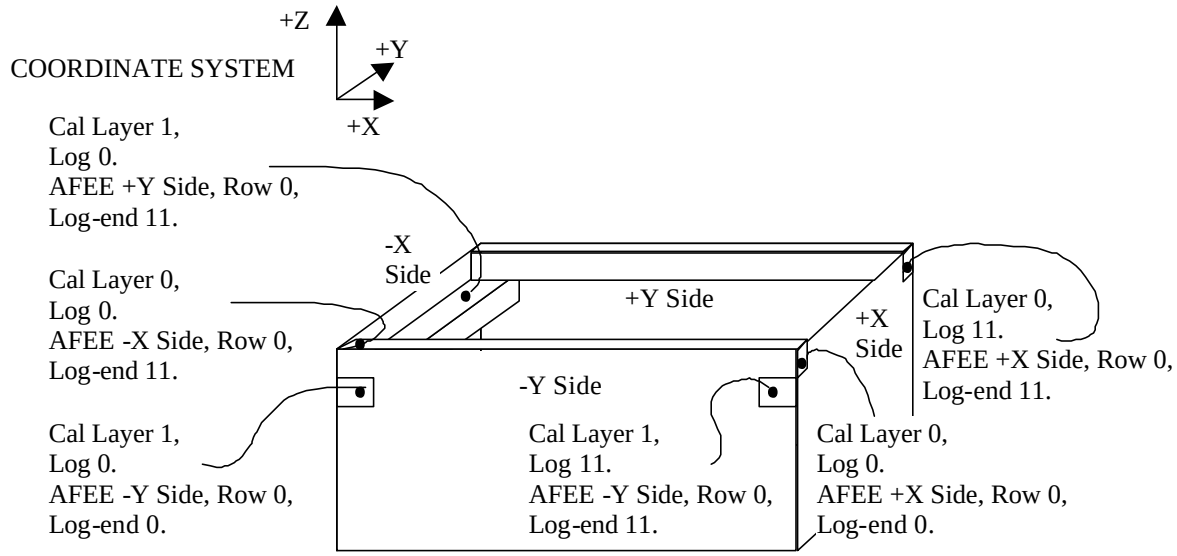


Figure 2-2 – CDE Numbering Scheme

2.2 Crystal Detector Element

The CDE is described in detail in either the CAL CsI Crystal Detector Element Specification for the Engineering Model (LAT-SS-00239) or the CAL Flight CsI CDE Specification (LAT-DS-01133).

The CDE is the detection unit of the LAT Calorimeter subsystem. It uses the scintillation properties of the CsI to determine the energy deposited by interacting particles. The primary scientific characteristics of the CDE are the Light Yield, expressed in terms of electrons/MeV at the output of the read out system (photodiodes), and its position dependence.

Each CDE is composed of the following parts:

- **CsI Crystal -** Primary detector element of the CDE. The crystal is shaped as a rectangular parallelepiped with a chamfer on the edges of the long dimension. The CsI Crystal Specification is given in LAT-DS-00095
- **PIN Photodiode Assemblies (PDA) -** Photodiode assemblies, which read out the light yield from the crystals. There are two PDA per CDE, one bonded to each end-face of the CsI crystal. Each PDA consists of:
  - One Dual PIN Photodiode (DPD) – reads out the light yield
  - Two sets of interconnect wire pairs are soldered between the leads of the DPD and the Analog Front End Electronics (AFEE card)
- **Optical Bond -** An optical adhesive is used to bond the PDAS onto the crystal end-faces. The adhesive preserves the high light yield and mechanical stability required over the large design temperature range
- **Optical Reflective Wrap** - A reflective material is wrapped around the four long sides and chamfers of the crystal to achieve high light collection efficiency
- **End-Caps** - Attached over bonded PDAs and optical reflective wrap at both ends of the crystal to close out the ends of the CDE

2.2.1 Interface with PEM Mechanical Structure

To ensure protection of the CDEs, no part of CDE must be or enter in direct contact with the structure. The mechanical interface is made by:

- Elastomeric cords positioned between the chamfers of the CDE and the inner radius at the four corners of the composite cell of the PEM mechanical structure
- Bumper frames positioned between the CDE end-caps and the close-out plates of the PEM assembly

These requirements are found in the PEM Mechanical Structure Specification (LAT-SS-00241) and the interface is defined the CAL Structure to CDE Interface Control Document (LAT-SS-00601).

2.2.2 Interface with Analog Front End Electronics

The CDEs interface with the Analog Front End Electronics (AFEE) by means of the wire pairs attached to the DPDs on each end. These wire pairs are inserted through access holes on the inner close out plates during final PEM assembly. In order to properly interface to the AFEE cards, the orientation of CDEs in the PEM must be such that the CDE label, located on the top side and '+' end of the CDE, points downward, in the –Z direction, for rows X0, X2, Y0, and Y2, and upward, in the +Z direction, for rows X1, X3, Y1, and Y3.

3 REQUIREMENTS

3.1 TOOLING

Tooling for CDE integration into the PEM structure must be certified. This tooling must provide:

- Precise alignment of the CDE into with the structure cell
- Attachment of the stretched elastomeric cords
- A physical stop for the CDE at an accurate position into the structure cell
- Support of the CDE to prevent warping of the crystal log
- Support of interconnect wire pairs to prevent damage to solder joints to the PIN diode

3.1.1 Tooling Certification

The CDE Insertion tooling shall be certified before commencing CDE insertion. Details concerning the certification of the CDE Insertion tooling is found in LAT-PS-0xxxx.

3.2 ASSEMBLY ENVIRONMENT

All PEM assembly operations shall be performed in a clean room environment with the conditions defined below.

3.2.1 Environmental Conditions

The temperature environment of the integration area in which the CAL Structure and CDE are integrated must be in the range of 20 to 25^{o}C (TBR). The humidity of the room will be maintained between 35% RH (TBR) and 45% RH (TBR). Temperature and humidity shall be monitored continuously and assembly operations shall be halted if conditions fail to meet these requirements. These requirements are detailed in the Calorimeter, Tracker, & Data Acquisition Contamination Control Plan, LAT-MD-00228.

3.3 OUTGASING AND CONTAMINATION

All materials used during CDE insertion activities shall meet the outgassing and contamination requirements specified in the Contamination Control plan (LAT-MD-000404). All personnel participating in assembly activities shall be trained in proper clean room etiquete as defined in the above mentioned plan.

3.4 CDE HANDLING

CDEs shall be stored, handled, and shipped using controlled procedures that guarantee minimum exposure to structural and mechanical loads and prevent exposure to moist or damp surfaces. These are described in the LAT CAL CsI Crystal and CDE Handling Procedure (LAT-PS-00809).

All ESD precautions per NASA-8739.7 will be followed. Tables and fixtures must be grounded to a common point. Once CDE insertion activities commence, only personnel trained in proper ESD procedures shall be allowed to participate in assembly activites.

4 PEM ASSEMBLY PLAN

Each CDE is inserted into the cells of the PEM structure using the procedure outlined in Section 4.1. Following insertion of all CDEs into the PEM structure, the close-out plates are installed using the outlines in Section 4.2. These procedural outlines are detailed in Section 5.0 and Section 6.0. The assembly sequence is as follows:

1) Insert 12 CDEs into row X3 of the Mechanical structure
2) Insertion of CDEs into Rows X2, X1, and X0 of the Mechanical structure
3) X-Side Close-Out Plate Installation onto the PEM Mechanical Structure
4) Insert 12 CDEs into row Y3 of the Mechanical structure
5) Insertion of CDEs into Rows Y2, Y1, and Y0 of the Mechanical structure
6) Y-Side Close-Out Plate Installation onto the PEM Mechanical Structure
7) Secure Corners of X and Y Close-Out Plates

4.1 CDE INSERTION

Initially, the composite structure is attached to the CDE Insertion tooling alignment plate. A carriage is precisely aligned so that the CDE module can be inserted into the desired structure cell. Once the CDE is in position, bumper frames are inserted on both ends. Once all CDE modules are inserted into the composite structure, the close-out plates are installed.

1) Installation and set-up of the PEM Mechanical Structure for Insertion Activities (detailed in Section 5.1)
    - Set-Up the CDE Insertion Tooling
    - Level the CDE Insertion Tooling Base Plate
    - Install Carriage Rails onto the Insertion Tooling Base Plate
    - Install the PEM Mechanical Structure to the Insertion Tooling Base Plate.
    - Verify that the indexed position of the (+) and (-) Carriages on the Carriage Rails corresponds to their associated composite cells on the PEM Mechanical Structure
2) Installation of the Elastic Cords (detailed in Section 5.2)
    - Insert the cords into the selected cell of the PEM Structure using the Cord Insertion Mandrel
    - Remove the cords from the Insertion Mandrel and secure them to the carriage cord supports
3) Installation of the CDE into the composite cell of the PEM Mechanical Structure (detailed in Section 5.3)
    - Install Wire Guide Blocks onto the ends of the CDE
    - Place CDE onto the (+) Carriage and start insertion of CDE into the cell of the PEM structure until the endcap exits the (-) end of the cell
    - Manipulate the (-) end of the CDE allowing the Elastic Cords to re-tension and shim the CDE into position
    - Move the CDE until it exits the (+) end of the cell
    - Manipulate the (+) end of the CDE allowing the Elastic Cords to re-tension and shim the CDE into position
    - Remove elastic cords from cord supports on the carriages
    - Manipulate (-) and (+) ends of the CDE again to allow the elastic cords to relax fully
    - Center CDE within cell using hard stop on the (-) Carriage and remove the shims
    - Evaluate free length of exposed cords to determine if rework is required

- Remove Wire Guide Blocks from the CDE
- Insert Bumper Frames onto the end of the CDE and cut excess exposed cord

4) CDE Removal from the PEM Mechanical Structure (detailed in Section 5.4)
   - Restore the elastic cords to the carriages
   - Remove the CDE Insertion Tooling
   - Install CDE Removal Tooling
   - Slide the CDE out of the PEM Structure
   - Remove the CDE Removal Tooling
   - Replace the CDE Insertion Tooling

4.2 CLOSE-OUT PLATE INSTALLATION

Once all CDE modules are inserted into the PEM structure, the wires of the PDAs are threaded through the close-out plates, by means of a threading tool. This tool is disassembled once the wires are all in their proper position. Details of the Close-Out Plate installation is found in Section 6.

1) Remove carriages and rails from the CDE Insertion Tooling Base Plate
2) Install the Guide Posts onto the inserts on the composite structure of the PEM Mechanical Structure
3) Place Close-Out Plate onto the inserts of the PEM Mechanical Structure
4) Install the Electronics Card Supports on either the X- and Y-ends of the Insertion Tooling Base Plate
5) Secure the Guide Posts onto each Electronics Card Support
6) Slide the Close-Out Plates toward the Electronics Card Support
7) Position the Close-Out Plates so that the wires can be inserted through the holes on the plate
8) Thread all wire pairs through the holes on both Close-Out Plates
9) Install the Close-Out Plate Nuts onto the Inserts
10) Use the Close-Out Plate Nuts to evenly draw the opposing Close-Out Plates together until the plates mate with the inserts
11) Tighten all fasteners for the Close-Out Plate to the specified torque
12) Remove the Electronics Card Support and Guide Posts from the CDE Insertion Tooling Base Plate

5 CDE INSERTION PROCEDURE

NOTE

ESD precautions per NASA-STD-8739 shall be followed.
Work Table and Fixtures shall be grounded.
Only personnel wearing ESD straps should be present during CDE insertion activities.

5.1 INSTALLATION AND SET UP OF THE CAL STRUCTURE FOR CDE INSERTION

1. Level the CDE Insertion Tooling Base Plate (GLT-LLR-TBD) on Granite Surface Table by adjusting the jack-screws. Verify that the plate is level on both axes with a carpenters level.
2. Install the X or Y Carriage Rails (GLT-LLR-TBD) onto the Insertion Tooling Base Plate.
   - Install the (+) carriage onto the rails on the side of the (+) face of the PEM Mechanical Structure
   - Install the (-) carriage onto the rails on the side of the (-) face of the PEM Mechanical Structure
3. Attach the braided ground cable to the Insertion Tooling Base Plate.

Figure 5.1-1: CDE Insertion Tooling Assembly

4. Attach PEM Mechanical Structure (LAT-DS-00241) onto the Insertion Tooling Base Plate.
   - Verify that X and Y markings on the PEM Mechanical Structure correspond to the X and Y markings on the Insertion Tooling
   - Verify that the PEM Mechanical Structure is placed against alignment pins and fasten with 8 mm bolts. Tighten the bolts to 15 in-lb

Figure 5.1-2: PEM Mechanical Structure Alignment

5.2 INSTALLATION OF THE ELASTIC CORDS

CAUTION

Ensure that wrist-strap is connected to ground during all operations involving CDEs and the PEM structure

1. Referring to the Work Order, select the cell position (row and column) that will be used for this installation
    - Record the cell position in the Work Order database
2. Using the detent feature on the carriage rails, index the position of the (+) and (-) Carriage to the corresponding cell of the PEM Mechanical Structure where the CDE will be installed. Verify proper alignment using the Teflon cord insertion mandrel (GLT-LLR-TBD) for each cell position.
3. Using a carpenters level, verify that the (+) Carriage is level. Adjust as necessary using the jack-stand.
4. Select two 1.0 mm diameter elastic cords and tie each one in a loop described in the procedure in Section 7.
    - Record the lot number of the elastic cords in the Work Order database
5. Loop the elastic cords onto the right and left side recesses of the Teflon cord insertion mandrel. (If elastic cords are knotted, the knotted ends should fit between the access notches of the Teflon mandrel as shown in Figure 5.2-1.

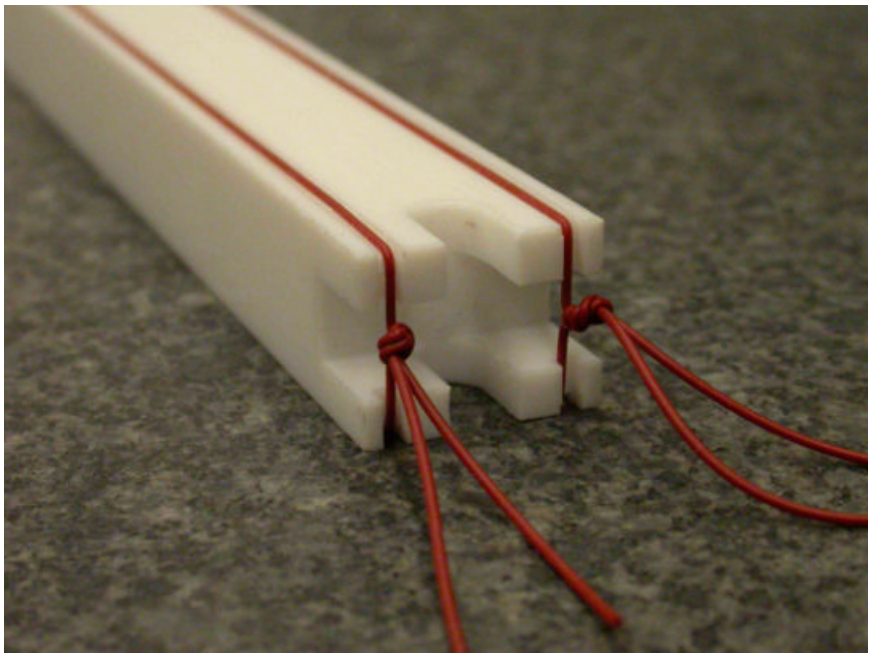


Figure 5.2-1: Elastic Cord Installation onto Cord Insertion Mandrel

6. Insert the cord insertion mandrel into the cell of the PEM Mechanical Structure.
7. Using the plastic hook, extract the elastic cord from the mandrel and loop it around the cord support of the (+) and (-) Carriages as shown in Figure 5.2-2.

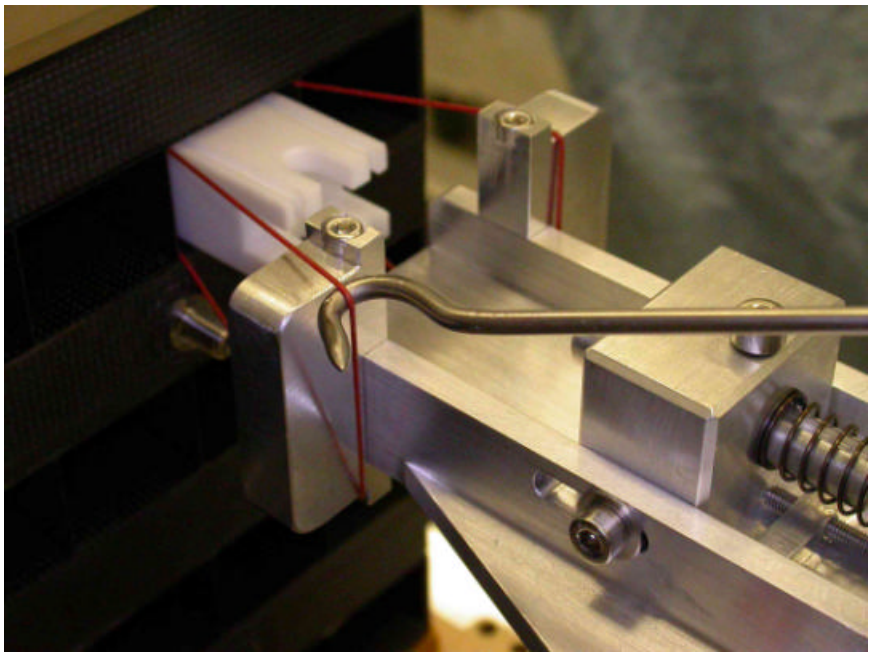


Figure 5.2-2: Installation of Elastic Cord onto Carriage

8. Remove the Teflon mandrel from the PEM structure.

9. Touch cords near the position where it makes contact with the structure to verify that the cords are not binding on the corner radius of the cell.

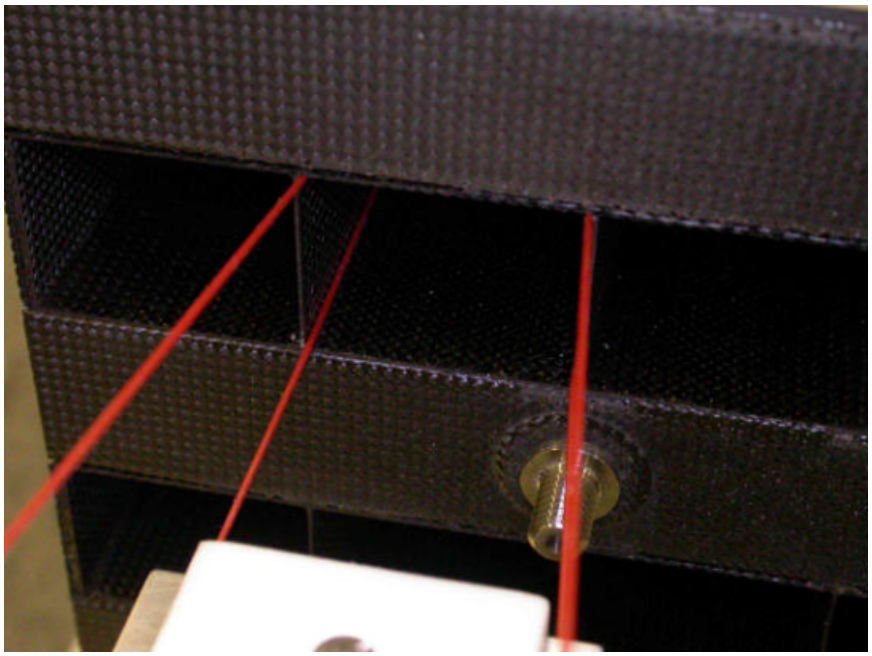


Figure 5.2-3: Proper Position of Elastic Cord at Opening of Composite Cell

10. Visually inspect the cell to verify that each cord is resting in their respective corner radius as shown in Figure 5.2-3. Reposition the cord, if necessary.

5.3 CDE Insertion

CAUTION

Ensure that wrist-strap is connected to ground during all operations involving CDEs and the PEM structure

1. Referring to the Work Order, select the next CDE that will be used for this installation.
   - Record the serial number of the CDE in the Work Order database
2. Verify that the terminators are connected to the PIN diode wires as shown in Figure 5.3-1.

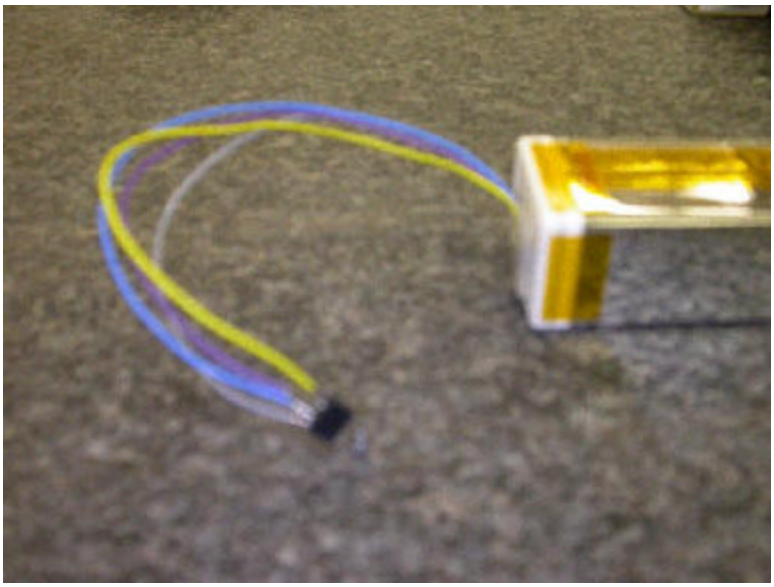


Figure 5.3-1 – PIN Diode Wire Termination

3. Without stressing the PIN diode wires on each end of the CDE, coil and insert them into the Teflon wire guide blocks as shown in Figure 5.3-2.

Figure 5.3-2 – Insert PIN Diode Wires into Wire Guide Block

4. Retract the hard-stop on the (-) Carriage as shown in Figure 5.3-3.

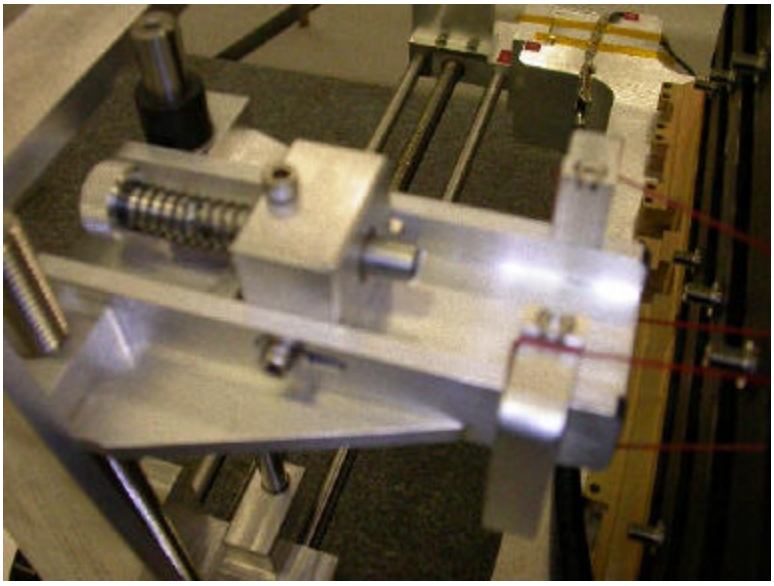


Figure 5.3-3 – Retract Hard Stop

5. Place CDE onto the (+) Carriage
   - Verify that the (+) end of the CDE is positioned so that it corresponds to the (+) face of the PEM Mechanical Structure after installation.
   - Verify CDE is positioned correctly for the selected cell. Refer to Table 5-1 for proper orientation. The orientation of each CDE within a cell is based on the CDE label position and the row that the CDE is installed within the PEM Mechanical Structure.

Table 5-1 – CDE Orientation Required for Insertion into X-Face of Structure

Cell	Row	Label
0	X0	Down
1	Y0	Down
2	X1	Up
3	Y1	Up
4	X2	Down
5	Y2	Down
6	X3	Up
7	Y3	Up

6. Insert the Teflon wire guide block into the (+) opening of the cell to start the CDE insertion as shown in Figure 5.3-4.

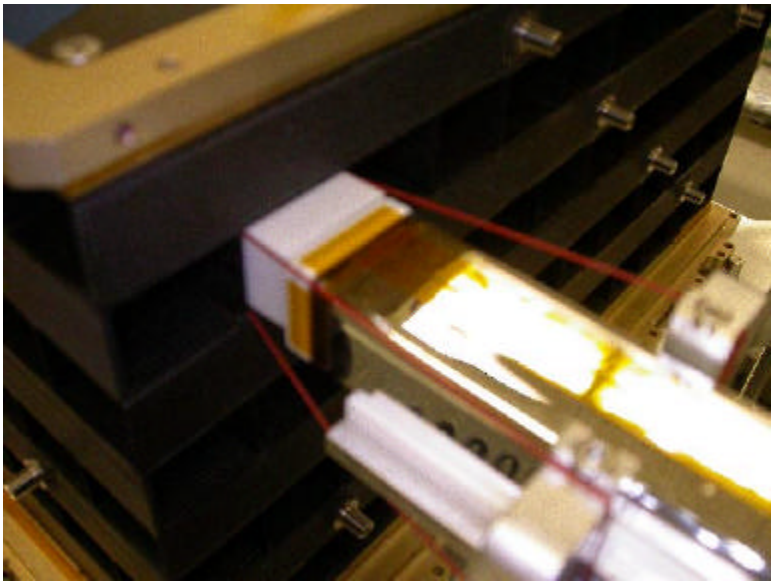


Figure 5.3-4 – Insert Wire Guide Block into Cell

7. Apply pressure to the Teflon wire guide block at the (+) end of the CDE to slowly slide the CDE toward the (+) face of the PEM Mechanical Structure. Guide the CDE as it approaches the cell so it does not bind at the opening.

8. Continue applying pressure to the Teflon wire guide block slowly sliding the CDE into the cell. The elastic cords at the (-) opening of the cell will lose tension as shown in Figure 5.3-5.

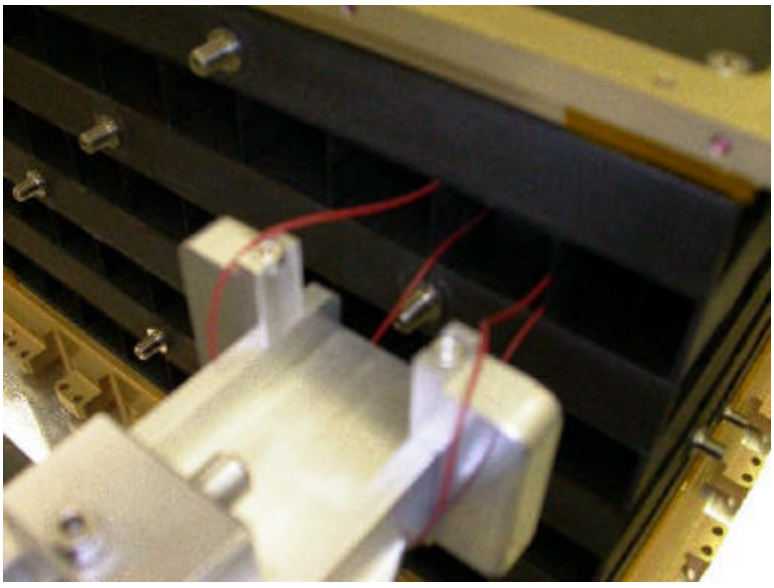


Figure 5.3-5 – Elastic Cords Losing Tension

9. As the (+)-side end cap approaches the (+) cell opening, insert 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE). This will prevent damage to the end caps as is passes through the opening. Continue to apply pressure as the end cap at the (+) end of the CDE exits the (-) side of the cell, where the cords will re-tension.

10. Continue to apply pressure until the end cap exits the (-) side of the cell, where the cords will re-tension. Figure 5.3-6 shows the elastic cords fully re-tensioned. The cords may not fully re-tension in some cases.

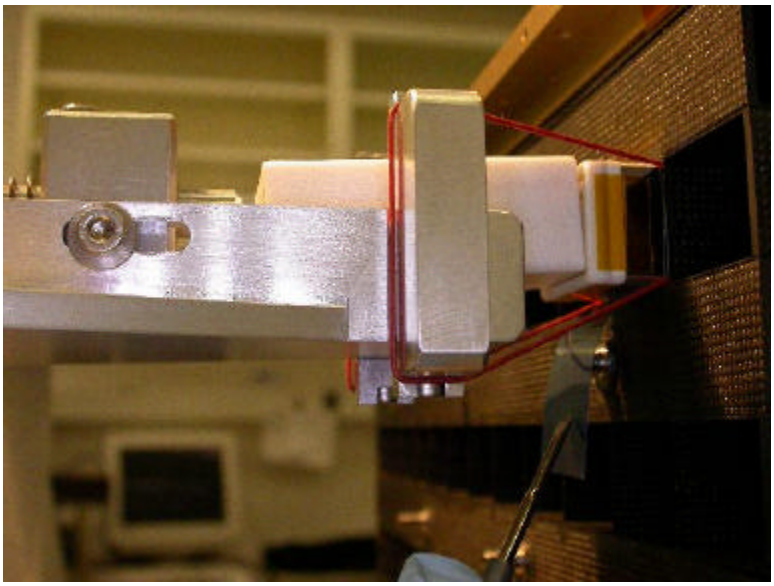


Figure 5.3-6 – Elastic Cords Re-tensioning

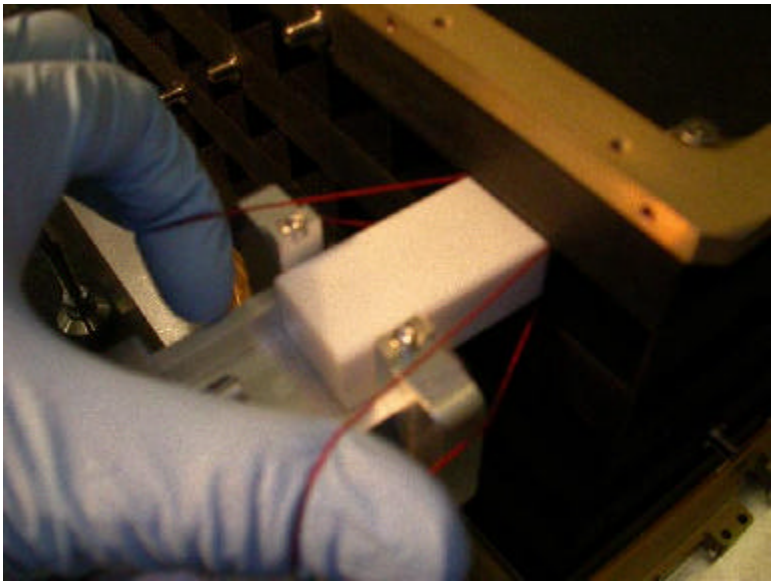
11. Manipulate the (-) end of the CDE to relieve pressure on the elastic cords, allowing them to re-tension more:
    - Lift the lower edge of the exposed CDE to relieve the pressure on the lower elastic cords
    - Press down on upper edge of exposed CDE to relieve the pressure on the upper elastic cords
    - Move the CDE side-to-side to also relieve the pressure on all the elastic cords
12. Insert a shim (0.13 mm thick) on the underside of the CDE at the (-) opening to raise the CDE slightly to remove pressure from the elastic cords along the bottom corners of the cell.
13. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (-) opening).
14. Apply pressure to the Teflon wire guide block at the (-) end of the CDE to slowly slide the CDE back into the cell. The elastic cords at the (+) opening of the cell may lose tension until the end cap exits the (+) side of the cell, where the cords will re-tension.
15. Remove the 0.08 mm shims from the (-) end of the CDE.
16. Manipulate the (+) end of the CDE, as before, to relieve pressure on the elastic cords, allowing them to re-tension more.
17. Insert a shim (0.13 mm thick) on the underside of the CDE at the (+) opening.
18. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (+) opening).
19. Position the hard-stop for the (-) Carriage at its STOP position.

20. Apply pressure to the Teflon wire guide block at the (+) end of the CDE to slowly slide the CDE back into the cell until the (-) Teflon wire guide block rests against the hard-stop. This axially centers the CDE within the cell.

21. Remove the 0.08 mm shims from the (+) end of the CDE.

22. Retract the hard-stop.

23. Simultaneously remove both elastic cord loops from the cord supports on the (-) Carriage to allow the cords to retract toward the CDE.



24. Simultaneously remove both elastic cord loops from the cord supports on the (+) Carriage to allow the cords to retract toward the CDE.

25. Apply pressure to the Teflon wire guide block at the (+) end of the CDE to slowly slide the (-) end of the CDE back out of the cell. The elastic cords at the (-) opening of the cell may retract as the end cap exits the (-) side of the cell.

26. Manipulate the (-) end of the CDE, as before, to relieve pressure on the elastic cords, allowing them to re-tension more.

27. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (-) opening).

28. Apply pressure to the Teflon wire guide block at the (-) end of the CDE to slowly slide the CDE back into the cell. The elastic cords at the (+) opening of the cell may lose tension until the end cap exits the (+) side of the cell, where the cords will re-tension.

29. Remove the 0.08 mm shims from the (+) end of the CDE.

30. Manipulate the (+) end of the CDE, as before, to relieve pressure on the elastic cords, allowing them to re-tension more.

31. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (+) opening).

32. Apply pressure to the Teflon wire guide block at the (+) end of the CDE to slowly slide the (-) end of the CDE back out of the cell. The elastic cords at the (-) opening of the cell may retract as the end cap exits the (-) side of the cell.

33. Remove the 0.08 mm shims from the (+) end of the CDE.

34. Manipulate the (-) end of the CDE, as before, to relieve pressure on the elastic cords, allowing them to re-tension more.

35. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (-) opening).

36. Apply pressure to the Teflon wire guide block at the (-) end of the CDE to slowly slide the CDE back into the cell. The elastic cords at the (+) opening of the cell may lose tension until the end cap exits the (+) side of the cell, where the cords will re-tension.

37. Remove the 0.08 mm shims from the (+) end of the CDE.

38. Manipulate the (+) end of the CDE, as before, to relieve pressure on the elastic cords, allowing them to re-tension more.

39. Position the hard-stop for the (-) Carriage at its STOP position.

40. Insert the 0.08 mm shims between the cell walls and the end cap (upper side and sides of CDE at the (-) opening).

41. Apply pressure to the Teflon wire guide block at the (+) end of the CDE to slowly slide the CDE back into the cell until the (-) Teflon wire guide block rests against the hard-stop. This axially centers the CDE within the cell.

42. Remove the 0.08 mm shims from the (+) end of the CDE.

43. Measure the remaining excess elastic cord exposed on the face of the cells of the carbon structure (for the cord loops on the left and right sides of the cell). Calculate the difference between the closed-loop length [756 mm $\pm$ 10 mm (766 mm $\pm$ 10 mm for 0.8 mm diameter cord)] and the exposed excess cord length, for each of the two elastic cords. This is the free length of the compressed cord. Verify that the free length of the compressed cords for each side is 500 mm – 600 mm.

    - If the free lengths of each of the compressed cords are less than 500 mm

      $\Rightarrow$ Notify Quality Assurance for direction

      $\Rightarrow$ Remove the CDE, if necessary, using the procedure outlined in Section 5.4

      $\Rightarrow$ If 1.0 mm diameter cords were used, then repeat Section 5.2 using 0.8 mm diameter cords, and repeat Steps 1 through 43 of this section using the same CDE

      $\Rightarrow$ If 0.8 mm diameter cords were used, halt operation and inform Quality Assurance

    - If the free lengths of each of the compressed cords are greater than 600 (TBC) mm:

      $\Rightarrow$ Remove the CDE using the procedure outlined in Section 5.4

      $\Rightarrow$ Inform Quality Assurance

44. Remove the 0.13 mm shim and Teflon wire guide block from the (+) opening of the cell.

45. Remove the 0.13 mm shim from the (-) opening of the cell.

46. Verify that the (-) Teflon wire guide block still rests against the hard-stop. The CDE is still centered axially within the cell.

47. Retract the hard-stop.

48. Remove the (-) Teflon wire guide block.

49. Install a Bumper Frame (LAT-DS-00925) over each cap being careful not to move the CDE axially within the cell.

50. Using sharp scissors, cut the remaining elastic cords even with the exposed face of each Bumper Frame. Discard the remaining elastic cords.

5.4 CDE Removal

CAUTION

Ensure that wrist-strap is connected to ground during all operations involving CDEs and the PEM structure

1. Restore elastic cords to loop around the cord supports of the (-) and (+) Carriages.
2. Remove the hard-stop set-screw hardware from the insertion tooling installed on the (-) Carriage.

Figure 5.4-1

3. Insert the CDE removal tool through the access in the hard-stop tooling and attach the Teflon removal guide block to the end of the removal tool.
4. Slowly apply pressure to the end of the CDE removal tool to slide the CDE through the cell and onto the (+) Carriage, stopping as soon as the CDE has fully exited the cell.
5. Remove the CDE and Teflon Wire Guide blocks from the (+) Carriage and place them onto the work surface. Remove the used elastic cords and discard.
6. Remove the Teflon Wire Guide blocks from the ends of the CDE and set them aside. Place the CDE back into the empty shipping container.
7. Slowly retract the CDE removal tool from the cell.
8. Remove the Teflon removal guide block from the end of the removal tool and remove the CDE Removal tool from the (-) Carriage.
9. Re-install the hard-stop set-screw into the insertion tooling on the (-) Carriage.

6 CLOSE-OUT PLATE INSTALLATION PROCEDURE

Close-Out Plates are installed as opposing pairs. Once 48 CDE modules are inserted into one side of the PEM Mechanical Structure, the wires of the PDAs are threaded through the Close-Out Plates, by means of a threading tool.

6.1 Close-Out Plate Installation

CAUTION

Ensure that wrist-strap is connected to ground during all operations involving CDEs and the PEM structure

1. Remove carriage and rails from the CDE Insertion Tooling Base Plate.
2. Install the Guide Posts (B8679) onto the Inserts (LAT-DS-00927) of the composite structure of the PEM Mechanical Structure.
3. Place Close-Out Plate (LAT-DS-00920/LAT-DS-00921) onto the inserts of the PEM Mechanical Structure.
4. Install the Electronics Card Supports (B8680/B8681) on the X-ends (or Y-ends) of the insertion tooling base plate.
5. Secure the guide posts onto each electronics card support using M2.5 fasteners.
6. Slide the close-out plates toward the Electronics Card Support.
7. Move Close-Out Plate toward the side of the PEM structure to a point where the wire pairs can be inserted through the holes on the plate.
8. Beginning with the bottom row of CDEs on the X-face (or Y-Face), thread the wire pairs from each of the CDEs through the holes on both close-out plates. Both wire pairs from each CDE pass through the hole on the close-out plate associated with the corresponding cell opening on the PEM structure.
9. After the wire pairs from the bottom row of CDEs has been threaded through the close-out plates on both sides of the PEM structure, move on to the next higher row of CDEs on the same face and thread those wire-pairs through the appropriate holes on the close-out plates on the Y-axis.
10. Continue to thread the remaining CDE wire pairs on the next higher row of the PEM structure, until the wire pairs from all 48 CDEs have been threaded through the opposing close-out plates.
11. Position the close-out plates against the elastic bumper frames on all four sides of the structure. Verify that the wires do not bind at the through-holes as the close-out plates are drawn toward the structure.
12. Install the Close-Out Plate Nuts (LAT-DS-00922) onto the inserts so that the close-out plate is touching, but not compressing, the Bumper Frames (LAT-DS-00925). Turn them on the threaded inserts until they touch the close-out plate.
13. Install the M2.5 cap head screws to secure the Close-Out Plates to the Top Frame (LAT-DS-00917) and Base Plate (LAT-DS-00919).
14. Use the close-out plate nuts to evenly draw the opposing close-out plates together until the plates mate with the inserts. Alternately tighten the nuts and screws on opposing sides to control the compression of the bumper frames using the torquing sequence shown in Figures 6.1-1 through 6.1-3. Tighten each fastener to 50% of its final torque specification.
15. Repeat Step 14 and tighten each fastener to 75% of its final torque specification.
16. Repeat Step 14 and tighten each fastener to 100% of its final torque specification.
17. Remove the Electronics Card Support and Guide Posts from the CDE Insertion Tooling Base Plate.

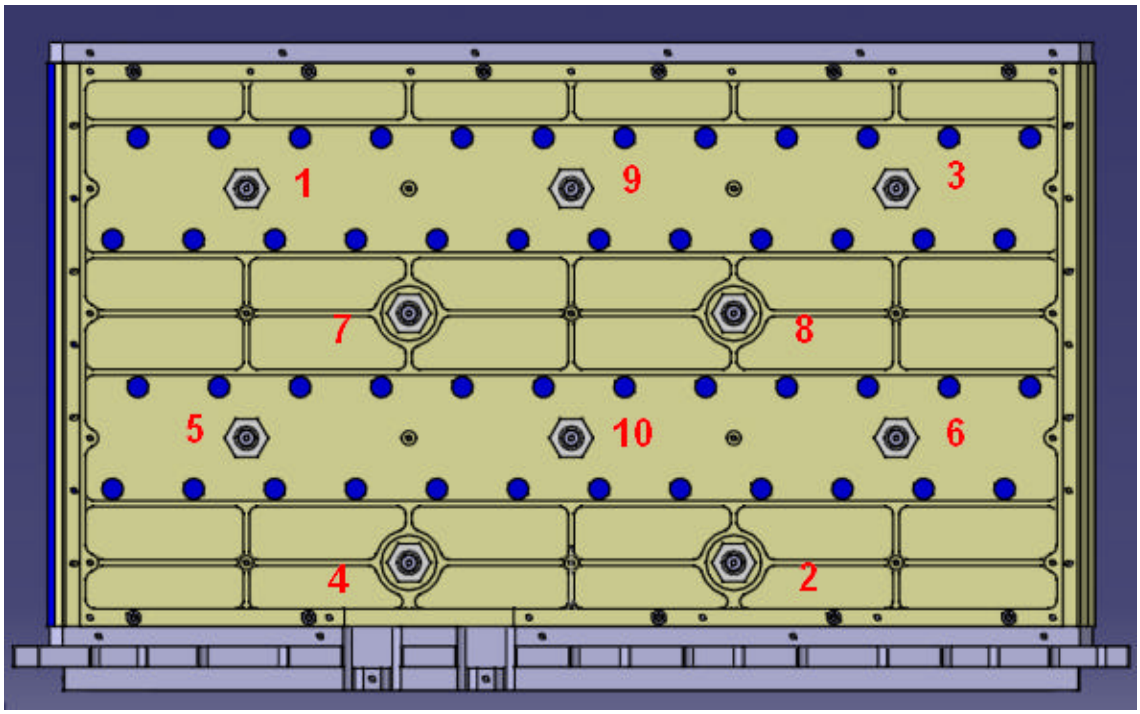


Figure 6.1-1: Torquing Sequence of the Close-Out Plate Nuts, X-Side

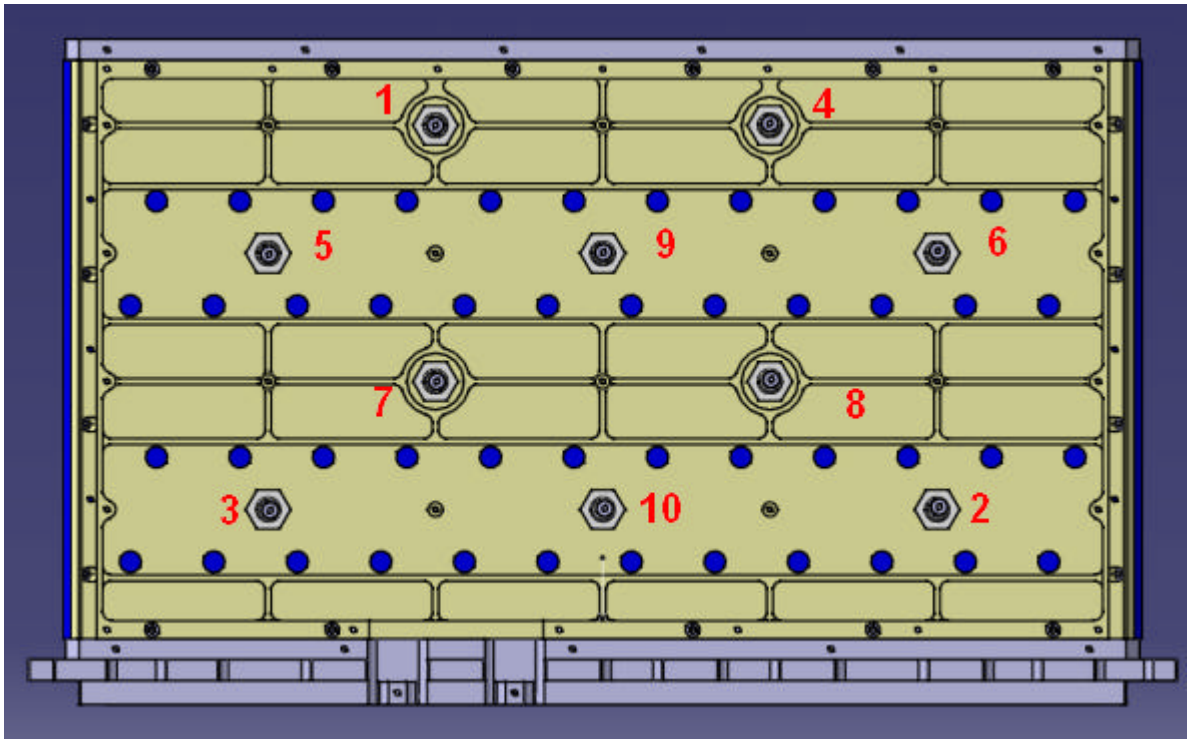


Figure 6.1-2: Torquing Sequence of the Close-Out Plate Nuts, Y-Side

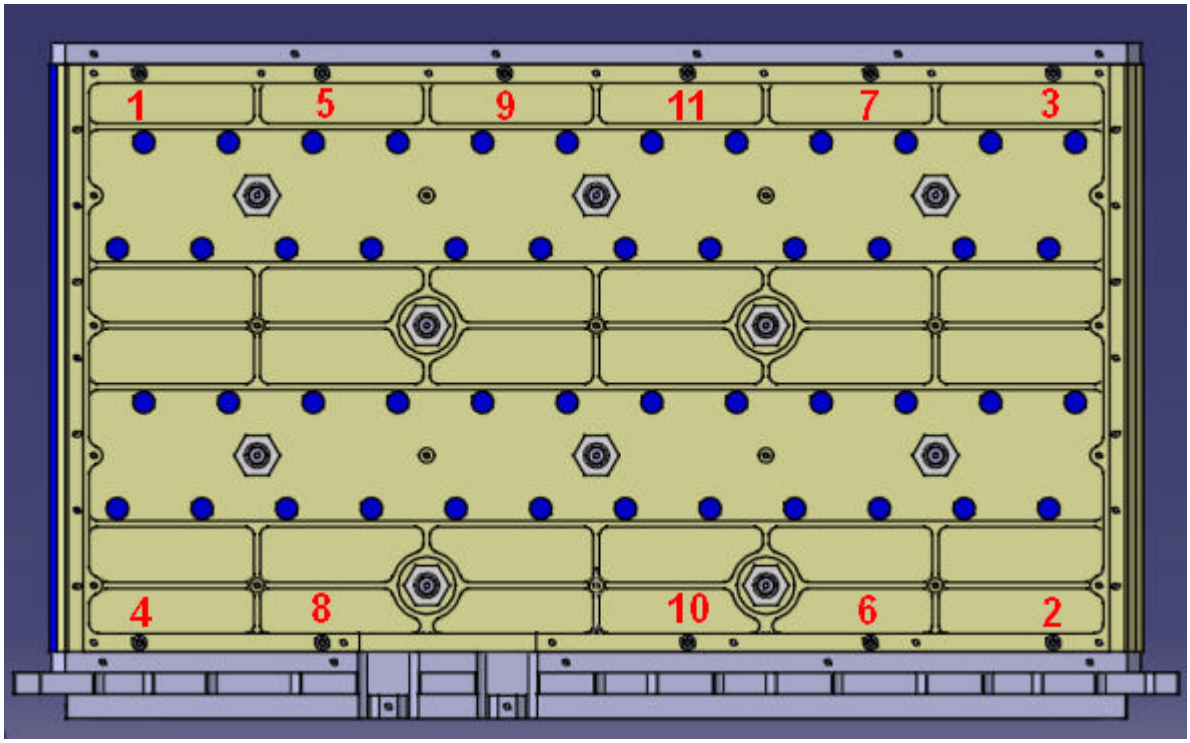


Figure 6.1-3: Torquing Sequence for Securing the Close-Out Plate to the Top Frame/Base Plate Assembly

6.2 Securing Close-Out Plates

When both the X and Y side Close-Out Plates are secured to the PEM Mechanical Structure, their corners must be secured to each other.

CAUTION

Ensure that wrist-strap is connected to ground during <u>all</u> operations involving CDEs and the PEM structure

1. Attach the Y Close-Out Plates to the X Close-Out Plates using the M2.5 fasteners at the corners. Tighten to running torque only.

2. Tighten the fasteners on each corner to 50% of its final torque specification. Start tightening with the upper and lower fasteners on each corner and end the tightening sequence with the two central fasteners.

3. Tighten the fasteners on each corner to 75% of its final torque specification using the sequence in Step 2.

4. Tighten the fasteners on each corner to 100% of its final torque specification using the sequence in Step 2.

6.3 Staking Close-Out Plate Fasteners

The procedure for staking of all PEM fasteners is described in Section 2.5.4 of GLAST-LLR-RP-065, PEM Assembly Procedure.

CAUTION

Ensure that wrist-strap is connected to ground during all operations involving CDEs and the PEM structure

1. Verify proper torque prior to staking.
2. Apply one dot of adhesive (Scotchweld 2216) between the fastener head and structure, avoiding adhesive placement on the socket recess, itself. Recommended time before handling is 8-12 hrs.
3. Remove the M8 bolts securing the completed PEM Assembly from the CDE Insertion Tooling Base Plate.
4. The CDEs in the PEM Assembly are now ready for check-out prior to AFEE board installation.

7 ELASTIC CORD MODIFICATION

The Looped Elastic cords used for the Engineering Model shall be made from straight elastic cord. The following procedure shall be followed to cut and tie elastic cords:

1. Cut two elastic cords to 800 mm length. Tie ends so that the closed-loop length is 756 mm + 10 mm (766 mm + 10 mm for 0.8 mm diameter cord) in length.
2. Use a Figure-8 knot to secure the ends.

Figure 7-1: Figure-8 Knot used for Tying Loop

3. When tightening the knot, pull only on both ends close to the knot so that the main portion of the cord is not stretched to its breaking point.

WARNING

Do not over stretch the elastic cord beyond 1.5x, which may introduce a permanent set into the cord

Figure 7-2: Tightening of Figure-8 Knot

8 CDE INSERTION WORKSHEET

Step	Event Description (Refer to LAT-PS-01225)		Work Order CDE Number												
			1	2	3	4	5	6	7	8	9	10	11	12	13
		CDE Serial Number													
		Column Position													
A	Tie elastic cords to proper loop length per Steps 1-3 of Section 7.	Inspect Length													
B	Install elastic cords per Steps 1-10 of Section 5.2.	Inspect/ Record Lot Number													
C	Verify that the terminators are connected to the PDA wires and secure wires with guide blocks per Steps 2 & 3 of Section 5.3. Inspect.	Verify													
D	Insert CDE into cell per Steps 4-9 of Section 5.3. Verify CDE orientation per Step 5 of Section 5.3	Verify CDE/PDA Orientation													
E	Manipulate CDE to relieve pressure on elastic cords per Steps 10-16 of Section 5.3														
F	Release tension on the elastic cords per Steps 17-19 of Section 5.3														
G	Manipulate CDE to relieve pressure on elastic cords per Steps 20-23 of Section 5.3														
H	Center the CDE within the cell on elastic cords per Steps 24-25 of Section 5.3														
I	Measure remaining excess cord and determine the free length of the compressed cord per Step 26 of Section 5.3. Record values.	Record Values													
J	Verify that the free length of the compressed cords are within spec, per Step 26 of Section 5.3. **If the values are out of spec, halt insertion.**	Verify													
K	Remove the shims per Step 27 of Section 5.3														
L	Remove the Teflon wire guide blocks per Steps 28-31 of Section 5.3														
M	Install Bumper Frame (LAT-DS-00925) over each end cap being careful not to move the CDE axially within the cell.	Inspect													
N	Cut remaining elastic cords even with the exposed face of each bumper frame and discard.	Inspect													
O	Position Insertion tooling to next column position.	Verify													